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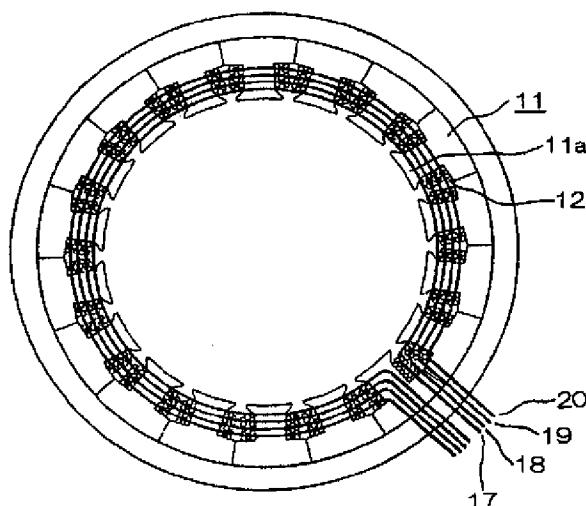
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**(54) Stator for rotary electromechanical device**

(57) A stator of a rotary electromechanical device comprises an annular stator core (11) in which a plurality of magnetic pole teeth (11a) projecting radially inward are formed at specific intervals in a circumferential direction, a plurality of coils (12) closely wound around the individual magnetic pole teeth (11a) with bobbins placed in between, a plurality of first connecting conductors (17, 18, 19) disposed in concentric circular form along an axial end face of the stator core (11), joining together terminal ends of each group of the coils (12) of the same

phase which are connected parallel to one another at one side of the coils (12), and a second connecting conductor (20) disposed in circular form concentrically with the individual first connecting conductors (17, 18, 19), joining together terminal ends of all the coils (12) at their opposite side, wherein extreme ends of the first and second connecting conductors (17, 18, 19, 20) are bent into radial directions at specific positions along the circumferential direction of the stator core (11) and led radially outward in a plane perpendicular to the axial direction of the stator core (11) at specific intervals.

FIG. 1



## Description

### BACKGROUND OF THE INVENTION AND RELATED ART STATEMENT

[0001] The present invention relates generally to a stator of an inner rotor type rotary electromechanical device and, more particularly, pertains to a wire-connecting structure for electrical connections of coils to the exterior of the device.

[0002] FIG. 6 is a diagram generally showing the construction of a stator of a conventional rotary electromechanical device disclosed in Japanese Laid-open Patent Publication No. 10-248187.

[0003] In this Figure, designated by the numeral 1 is an annular stator core in which a plurality of magnetic pole teeth 1a projecting radially inward are formed at specific intervals in a circumferential direction, designated by the numeral 2 are a plurality of coils closely wound around the individual magnetic pole teeth 1a, designated by the numerals 3, 4 and 5 are first connecting conductors disposed in concentric ringlike form along an axial end face of the stator core 1, joining terminal ends of the coils 2 of each phase (U, V, W) together at one end, and designated by the numeral 6 is a second connecting conductor disposed in ringlike form concentrically with the individual first connecting conductors 3, 4, 5, joining terminal ends of all the coils 2 together at the other end. Outlet conductors 3a, 4a, 5a and 6a individually connected to the first and second connecting conductors 3, 4, 5, 6 for establishing electrical connections between the rotary electromechanical device and its exterior extend radially outward as illustrated.

[0004] In the conventional rotary electromechanical device whose the stator is constructed as described above, the coils 2 of the U phase are connected to the first connecting conductor 3 at their one end, the coils 2 of the V phase are connected to the first connecting conductor 4 at their one end, and the coils 2 of the W phase are connected to the first connecting conductor 5 at their one end, for example, to combine them electrically, and the coils 2 are all connected to the second connecting conductor 6 at their common terminal side and to external equipment via the individual outlet conductors 3a, 4a, 5a, 6a.

[0005] As stated above, the stator of the conventional rotary electromechanical device is constructed such that the first connecting conductors 3, 4, 5 to which the coils 2 of the individual phases (U, V, W) are connected at one end and the second connecting conductor 6 to which the coils 2 are all connected at the other end are led to the exterior of the device via the respective outlet conductors 3a, 4a, 5a, 6a. As is obvious from the Figure, the outlet conductor 4a runs across the first connecting conductor 3, the outlet conductor 5a runs across the connecting conductors 3 and 4, and the outlet conductor 6a runs across the connecting conductors 3, 4 and 5, and these outlet conductors 4a, 5a, 6a are led to the

exterior radially outward. This construction has a problem that crossover portions of the outlet conductors 4a, 5a, 6a bulge out in the axial direction of the stator core 1, making it difficult to reduce its thickness.

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### SUMMARY OF THE INVENTION

[0006] The present invention has been made to solve the aforementioned problem of the prior art. Accordingly, it is an object of the invention to provide a stator of a rotary electromechanical device which makes it possible to reduce the stator thickness.

[0007] According to a principal feature of the invention, a stator of a rotary electromechanical device comprises an annular stator core in which a plurality of magnetic pole teeth projecting radially inward are formed at specific intervals in a circumferential direction, a plurality of coils closely wound around the individual magnetic pole teeth with bobbins placed in between, a plurality of first connecting conductors disposed in concentric circular form along an axial end face of the stator core, joining together terminal ends of each group of the coils of the same phase which are connected parallel to one another at one side of the coils, and a second connecting conductor disposed in circular form concentrically with the individual first connecting conductors, joining together terminal ends of all the coils at their opposite side, wherein extreme ends of the first and second connecting conductors are bent into radial directions at specific positions along the circumferential direction of the stator core and led radially outward in a plane perpendicular to the axial direction of the stator core at specific intervals.

[0008] This construction makes it possible to reduce the thickness of the stator of a rotary electromechanical device.

[0009] In one aspect of the invention, an annular area where the first and second connecting conductors are disposed falls within an annular area where the coils are wound. This enables a further reduction in the thickness of the stator of a rotary electromechanical device.

[0010] In another aspect of the invention, the first and second connecting conductors are held by insulating retainer members disposed at specific intervals in the circumferential direction. This enables not only a reduction in the thickness of the stator of a rotary electromechanical device but also an improvement in its reliability.

[0011] In still another aspect of the invention, the insulating retainer members are fixed to the respective bobbins on which the coils are wound. This construction makes it possible to provide a stator of a rotary electromechanical device which allows an improvement of the efficiency of assembly, not to mention an improvement in reliability.

[0012] In yet another aspect of the invention, joints between the first and second connecting conductors and the terminal ends of the individual coils are accommodated inside the insulating retainer members. This con-

struction enables a further increase in reliability.

[0013] In a further aspect of the invention, non-woven fabric is attached to areas of the insulating retainer members where the joints between the first and second connecting conductors and the terminal ends of the individual coils are located. This enables an improvement in insulating performance, not to mention an improvement in reliability.

[0014] In a still further aspect of the invention, the first and second connecting conductors are tied to the respective bobbins by insulating threads. This construction makes it possible to achieve a further improvement in reliability, not to mention a reduction in the thickness of the stator.

[0015] These and other objects, features and advantages of the invention will become more apparent upon reading the following detailed description in conjunction with the accompanying drawings.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0016]

FIG. 1 is a plan view generally showing the construction of a stator of a rotary electromechanical device according to a preferred embodiment of the present invention;

FIG. 2 is a wiring diagram showing connections between coils and respective outlet conductors of the stator of the rotary electromechanical device of FIG. 1;

FIG. 3 is an enlarged fragmentary plan view showing the construction of a principal part of the stator of the rotary electromechanical device of FIG. 1;

FIG. 4 is a cross-sectional view taken along lines IV-IV of FIG. 3;

and FIG. 5 is an exploded perspective view showing the construction of a cover, an insulating retainer member and a bobbin shown in FIG. 4; and

FIG. 6 is a plan view generally showing the construction of a stator of a conventional rotary electromechanical device.

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION**

[0017] A preferred embodiment of the invention is now described below with reference to the drawings.

[0018] FIG. 1 is a plan view generally showing the construction of a stator of a rotary electromechanical device according to the embodiment of the present invention; FIG. 2 is a wiring diagram showing connections between coils and respective connecting conductors of the stator of the rotary electromechanical device of FIG. 1; FIG. 3 is an enlarged fragmentary plan view showing the construction of a principal part of the stator of the rotary electromechanical device of FIG. 1; FIG. 4 is a cross-sectional view taken along lines IV-IV of FIG. 3;

and FIG. 5 is an exploded perspective view showing the construction of one each cover 15, insulating retainer member 14 and bobbin 13 shown in FIG. 4. It is to be noted that later-described bobbins 13 and insulating retainer members 14 are not illustrated in FIG. 1.

[0019] In these Figures, designated by the numeral 11 is an annular stator core in which a plurality of magnetic pole teeth 11a projecting radially inward are formed at specific intervals in a circumferential direction, designated by the numeral 12 are a plurality of coils closely wound around the individual magnetic pole teeth 11a with the aforementioned bobbins 13 placed in between, and designated by the numeral 13 is one of the bobbins 13 made of an insulating material, each bobbin 13 including a barrel portion 13a having a U-shaped cross section and a pair of end plates 13b, 13c formed at both ends of the barrel portion 13a as depicted in FIG. 5. The bobbins 13 are disposed in pairs in such a manner that each magnetic pole tooth 11a is sandwiched between inner surfaces of the barrel portions 13a of two bobbins 13 located at both ends in the axial direction of the stator. The coil 12 is wound around the barrel portions 13a of each bobbin pair 13. There are formed cutouts 13d in the end plate 13b at one end of each bobbin 13 for passing later-described lead wires 21, 22 which are connected to terminal ends of the coil 12 while a cutout 13e, in which a projecting part 14d of each insulating retainer member 14 is fitted, is formed in the end plate 13c at the other end.

[0020] Designated by the numeral 14 is the aforementioned insulating retainer member which has four grooves 14a formed in a top surface with specific intervals widthwise, grooves 14b and 14c opening upward and downward, respectively, formed at one end by bending operation, and the aforementioned projecting part 14d formed at the opposite end, as shown in FIG. 5. The insulating retainer member 14 is locked to the corresponding bobbin 13 by fitting the groove 14c at one end onto the end plate 13b of the bobbin 13 and the projecting part 14d at the other end into the cutout 13e of the end plate 13c. Designated by the numeral 15 is the aforementioned cover which is fitted to the top of the insulating retainer member 14, in which a flange 15a for covering the groove 14b of the insulating retainer member 14 is formed at one end of the cover 15 as shown in FIG. 5.

[0021] The insulating retainer member 14 and the cover 15 are attached to each of the bobbins 13 provided at one axial end face of the stator core 11, and later-described first and second connecting conductors 17, 18, 19, 20 are accommodated in the grooves 14a formed in the each insulating retainer member 14. Therefore, an annular area where the first and second connecting conductors 17, 18, 19, 20 are disposed falls within an annular area where the individual coils 12 are wound. This means that the first and second connecting conductors 17, 18, 19, 20 can be run between the end plates 13b, 13c of the individual bobbins 13 so that an

increase in physical dimensions in the axial direction of the stator core 11 can be minimized.

**[0022]** Designated by the numeral 16 are pieces of non-woven fabric which line inside surfaces of both grooves 14a, 14b formed in each insulating retainer member 14, designated by the numerals 17, 18 and 19 are the aforementioned first connecting conductors which are disposed in concentric circular form along the axial end face of the stator core 11 in the annular area where the coils 12 are wound, and designated by the numeral 20 is the aforementioned second connecting conductor disposed concentrically with the first connecting conductors 17, 18, 19 on their outside. These first and second connecting conductors 17, 18, 19, 20 are retained in the respective grooves 14a formed in the insulating retainer members 14 which are disposed at specific positions along the circumferential direction, the grooves 14a being lined with the non-woven fabric 16, wherein both ends of each of the connecting conductors 17, 18, 19, 20 are bent into radial directions at specific positions along the circumferential direction of the stator core 11 and taken out to the exterior at specific intervals as shown in FIG. 1.

**[0023]** In this arrangement, neither of the connecting conductors 17, 18, 19, 20 is formed into a closed ring, but their extreme ends are led radially outward in a plane perpendicular to the axial direction of the stator core 11 in a manner that they do not overlap one another as shown in FIG. 1.

**[0024]** In this embodiment, the coils 12 are parallel-connected in groups of six to constitute three phases (U, V, W) as shown in FIG. 2, for example. The terminal ends of the parallel-connected coils 12 of the U phase are connected to the first connecting conductor 17 at one side, the terminal ends of the parallel-connected coils 12 of the V phase are connected to the first connecting conductor 18 at one side, and the terminal ends of the parallel-connected coils 12 of the W phase are connected to the first connecting conductor 19 at one side via the respective lead wires 21. Also, the terminal ends of all the coils 12 to be joined to a neutral point are connected to the second connecting conductor 20 at the opposite side via the respective lead wires 22. The connecting conductors 17, 18, 19, 20 and the lead wires 21, 22 insulated by the non-woven fabric 16 are then accommodated in the grooves 14a, 14b as shown in FIGS. 3 and 4.

**[0025]** Finally, after covering the individual grooves 14a, 14b by fitting the covers 15 to the top of the individual insulating retainer members 14, an insulating thread 23 is wound around each assembly of the bobbin pair 13, the insulating retainer member 14 and the cover 15. More specifically, the insulating thread 23 is wound from one end of the assembly to the opposite end over the inside of the barrel portion 13a of each bobbin pair 13 and, folded at the opposite end side, turned back to the starting point of winding over a top surface of the cover 15. The insulating thread 23 is wound around the

assembly several times in this fashion to bind the insulating retainer member 14 and the cover 15 to the bobbin pair 13 and to securely hold the connecting conductors 17, 18, 19, 20 and the lead wires 21, 22 in the insulating retainer members 14.

**[0026]** According to the present embodiment, both ends of each of the first connecting conductors 17, 18, 19 joining together the terminal ends of the parallel-connected coils 12 of the same phase (U, V, W) at one side as well as both ends of the second connecting conductor 20 joining together the terminal ends of all the coils 12 at the opposite side are bent into the radial directions at the specific positions along the circumferential direction of the stator core 11 and led radially outward in the plane perpendicular to the axial direction of the stator core 11 at specific intervals as described above, the four connecting conductors 17, 18, 19, 20 being disposed in concentric circular form. In this construction, the individual connecting conductors 17, 18, 19, 20 do not cross one another, so that they do not bulge out in the axial direction of the stator core 11, making it possible to reduce its thickness.

**[0027]** Since the first and second connecting conductors 17, 18, 19, 20 are disposed within the annular area where the individual coils 12 are wound, just between the end plates 13b, 13c of the individual bobbins 13, it is possible to prevent the connecting conductors 17, 18, 19, 20 from further bulging out in the axial direction of the stator core 11. Also, since the first and second connecting conductors 17, 18, 19, 20 are accommodated within the insulating retainer members 14, it is possible to hold the connecting conductors 17, 18, 19, 20 in a stably fixed position, and by binding them with the insulating threads 23, it is possible to achieve increased reliability. Furthermore, since the stator core 11 is constructed such that each insulating retainer member 14 can be locked onto its corresponding bobbin 13, the invention serves to improve the efficiency of assembly.

**[0028]** Furthermore, since joints between the first and second connecting conductors 17, 18, 19, 20 and the lead wires 21, 22, which connect the connecting conductors 17, 18, 19, 20 to the coils 12, are accommodated inside the insulating retainer members 14, the lead wires 21, 22 are not exposed to the exterior and, thus, they do not spoil the appearance. Moreover, the inside surfaces of the grooves 14a, 14b formed in the insulating retainer members 14, in which the lead wires 21, 22 are accommodated, are lined with the non-woven fabric 16, so that the non-woven fabric 16 absorbs liquid resin when it is applied to the aforementioned joints for electrical insulation, and this further improves insulation.

#### Claims

1. A stator for a rotary electromechanical device, comprising

- an annular stator core (11) in which a plurality of magnetic pole teeth (11a) projecting radially inwardly are formed at specific intervals in a circumferential direction;
- a plurality of coils (12) closely wound around the individual magnetic pole teeth (11a) with bobbins (13) placed in between;
- a plurality of first connecting conductors (17, 18, 19) disposed in concentric circular form along an axial end face of the stator core (11), joining together terminal ends of each group of the coils (12) of the same phase which are connected parallel to one another at one side of the coils (12); and
- a second connecting conductor (20) disposed in circular form concentrically with the individual first connecting conductors (17, 18, 19), joining together terminal ends of all the coils (12) at their opposite side;

wherein the first and second connecting conductors (17-19; 20) are tied to the respective bobbins (13) by insulating threads (23).

wherein extreme ends of the first and second connecting conductors (17-19; 20) are bent into radial directions at specific positions along the circumferential direction of the stator core (11) and led radially outwardly in a plane perpendicular to the axial direction of the stator core (11) at specific intervals.

2. The stator according to claim 1, wherein an annular area where the first and second connecting conductors (17-19; 20) are disposed falls within an annular area where the coils (12) are wound.
3. The stator according to claim 1 or 2, wherein the first and second connecting conductors (17-19; 20) are held by insulating retainer members (14) disposed at specific intervals in the circumferential direction.
4. The stator according to claim 3, wherein the insulating retainer members (14) are fixed to the respective bobbins (13) on which the coils (12) are wound.
5. The stator according to claim 3 or 4, wherein joints between the first and second connecting conductors (17-19; 20) and the terminal ends of the individual coils (12) are accommodated inside the insulating retainer members (14).
6. The stator according to claim 5, wherein non-woven fabric (16) is attached to areas of the insulating retainer members (14) where the joints between the first and second connecting conductors (17-19; 20) and the terminal ends of the individual coils (12) are located.
7. The stator according to any of claims 1 to 6,

FIG. 1

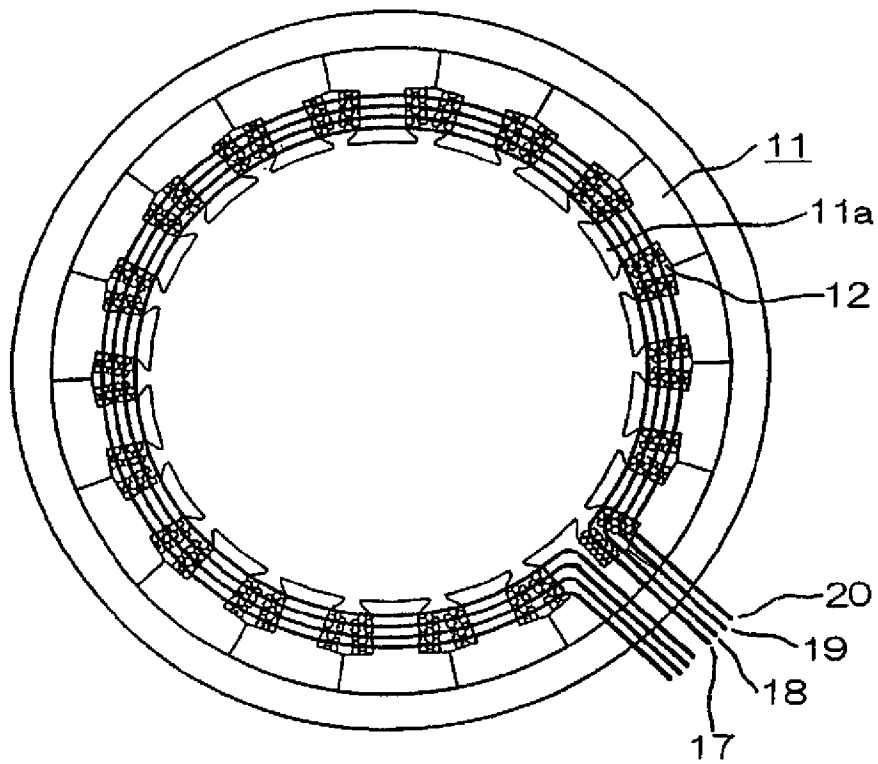


FIG. 2

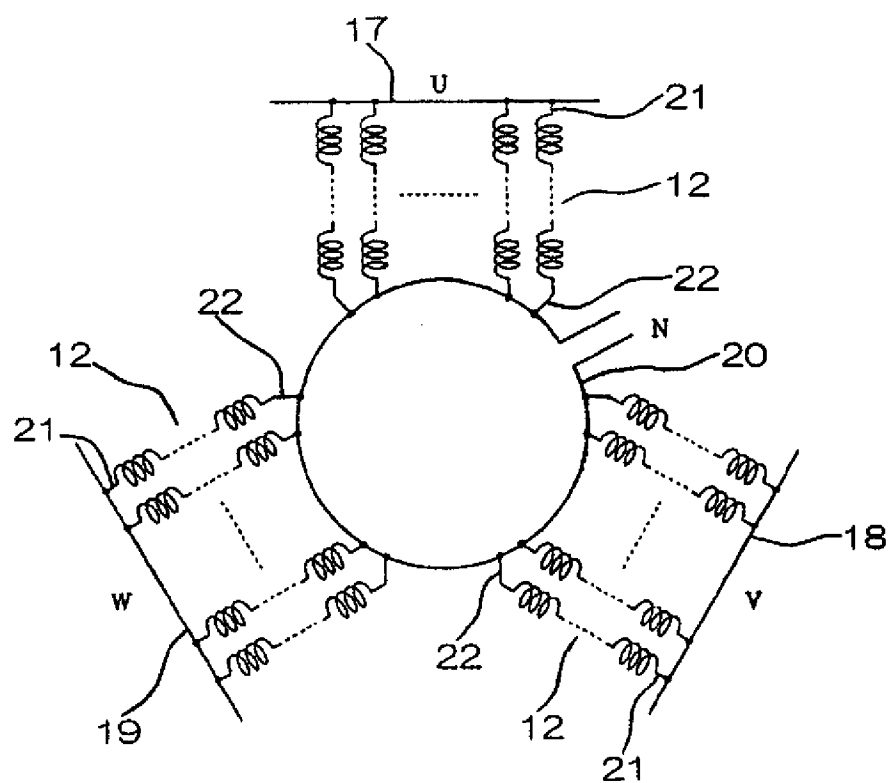


FIG.3

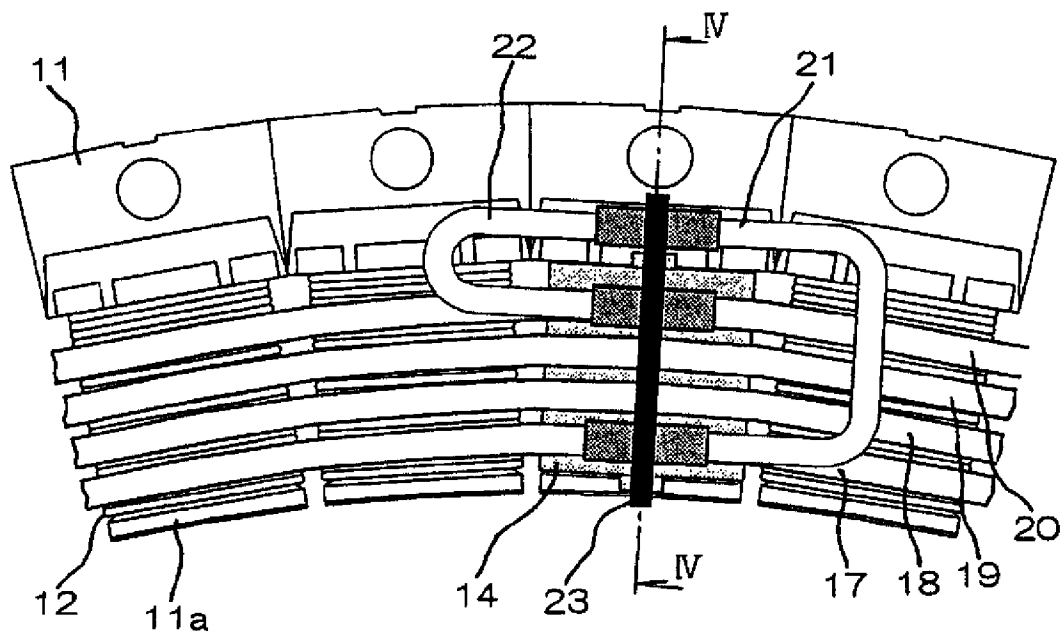




FIG. 4

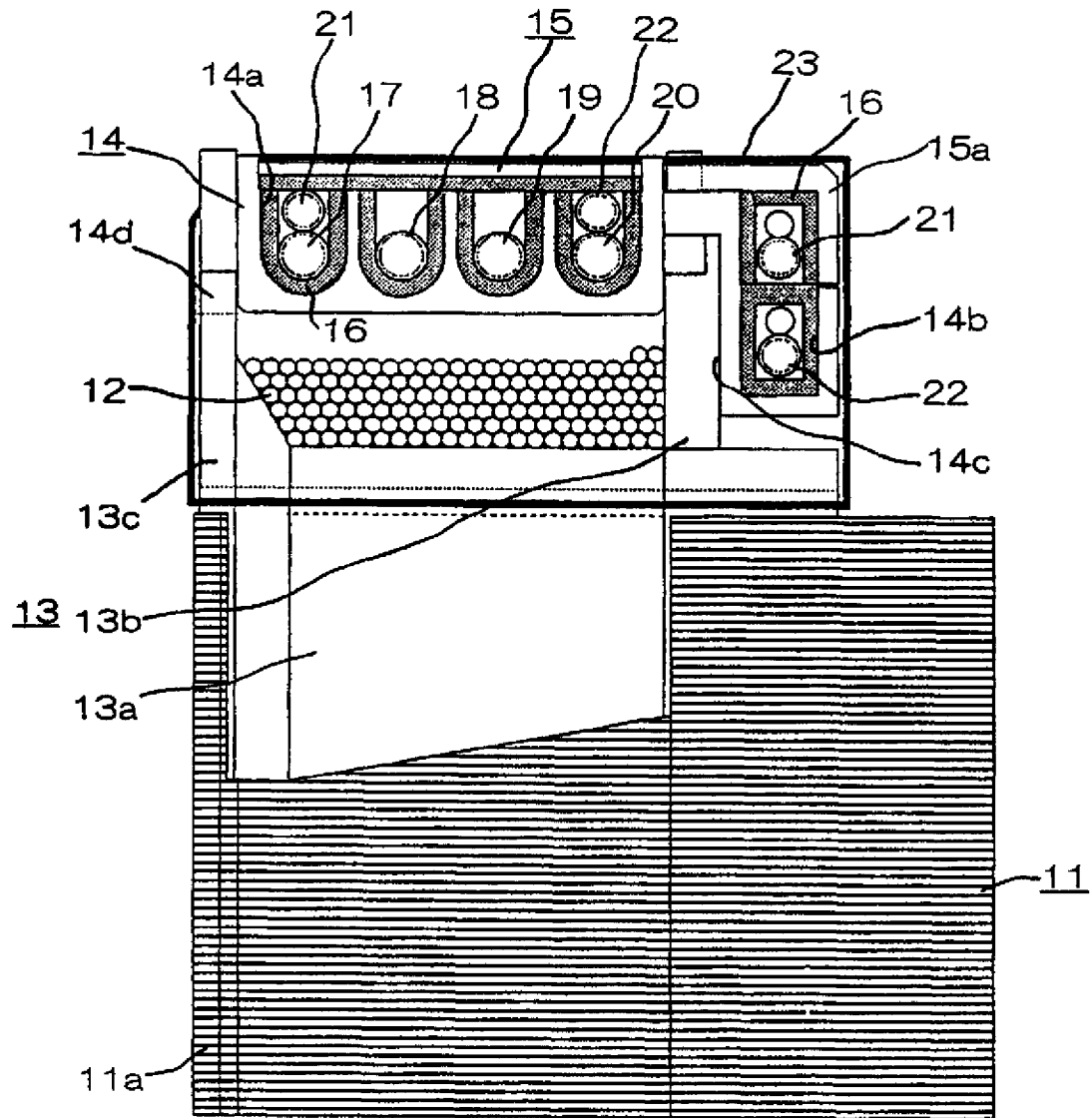


FIG. 5

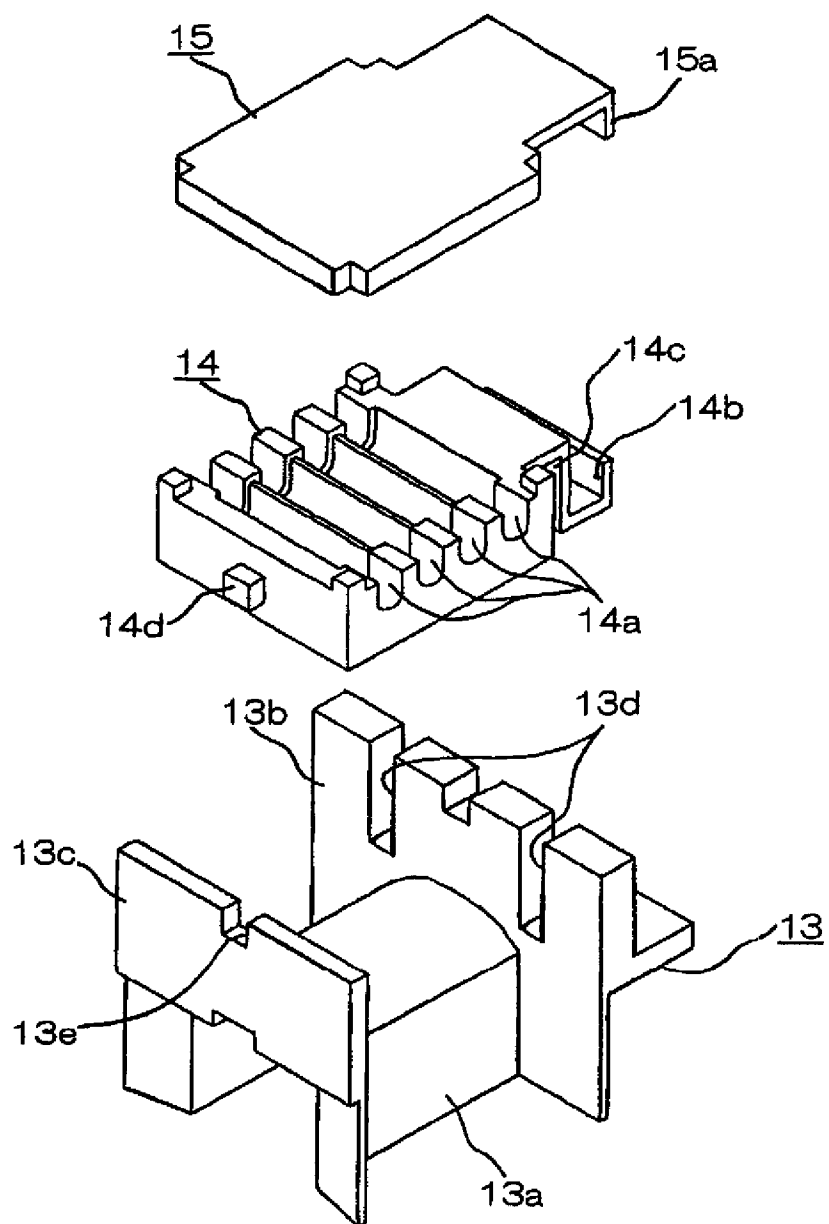
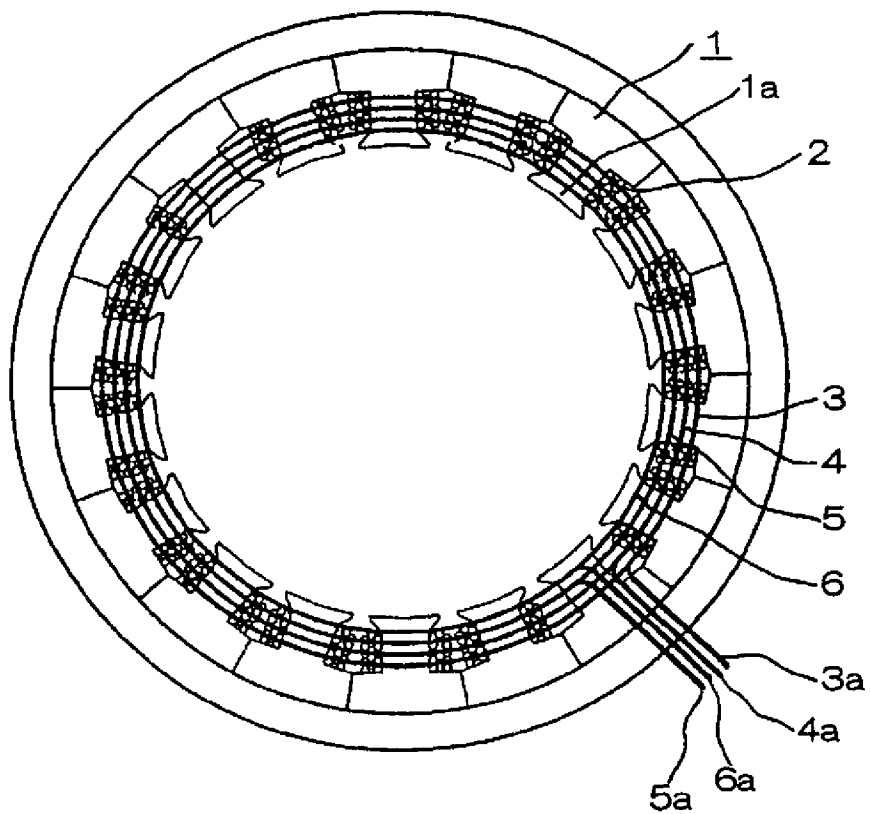
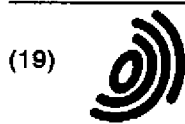


FIG. 6  
"PRIOR ART"







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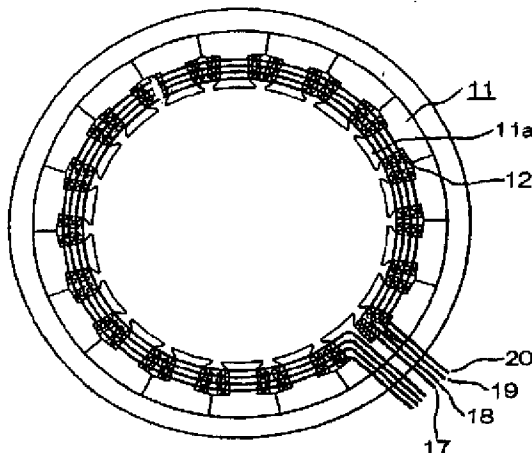
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(54) **Stator for rotary electromechanical device**

(57) A stator of a rotary electromechanical device comprises an annular stator core (11) in which a plurality of magnetic pole teeth (11a) projecting radially inward are formed at specific intervals in a circumferential direction, a plurality of coils (12) closely wound around the individual magnetic pole teeth (11a) with bobbins placed in between, a plurality of first connecting conductors (17, 18, 19) disposed in concentric circular form along an axial end face of the stator core (11), joining together terminal ends of each group of the coils (12) of the same phase which are connected parallel to one another at one side of the coils (12), and a second connecting conductor (20) disposed in circular form concentrically with the individual first connecting conductors (17, 18, 19), joining together terminal ends of all the coils (12) at their opposite side, wherein extreme ends of the first and second connecting conductors (17, 18, 19, 20) are bent into radial directions at specific positions along the circumferential direction of the stator core (11) and led radially outward in a plane perpendicular to the axial direction of the stator core (11) at specific intervals.

FIG. 1

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# EUROPEAN SEARCH REPORT

Application Number  
EP 01 12 0517

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 863 601 A (MATSUSHITA ELECTRIC IND CO LTD) 9 September 1998 (1998-09-09)	1,2	H02K3/28 H02K3/52
Y	* column 3, lines 41-57; figures 1,2,5-7 *	3,4,7	
	* column 4, lines 2-12 *		
	* column 4, lines 21-27 *		
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Y	PATENT ABSTRACTS OF JAPAN vol. 0060, no. 60 (E-102), 17 April 1982 (1982-04-17) & JP 57 001202 A (NORDSON KK), 6 January 1982 (1982-01-06) * abstract; figures 1,2 *	3,4,7	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H02K
The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>16 July 2004</b>	Examiner <b>Strasser, T</b>
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : technological background O : non-written disclosure P : intermediate document & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 12 0517

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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16-07-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0863601	A	09-09-1998	JP 3430839 B2	28-07-2003
			JP 10248187 A	14-09-1998
			DE 69800298 D1	19-10-2000
			DE 69800298 T2	18-01-2001
			EP 0863601 A1	09-09-1998
			US 5900687 A	04-05-1999
-----				
JP 57001202	A	06-01-1982	NONE	
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